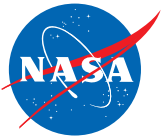


Update on the Aqua Mission

Claire L. Parkinson
Aqua Project Scientist
NASA Goddard Space Flight Center

Presented at the NASA Sounder Science Team Meeting,
Greenbelt Marriott Hotel, Greenbelt, Maryland, September 13, 2016



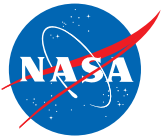
Aqua Overview

- Aqua was launched on May 4, 2002, with six Earth-observing instruments and a 6-year design life; it has now been in orbit around the Earth at an altitude of 705 km for over 14 years.
- Aqua was the first satellite in what has become the A-Train.
- Thousands of scientific publications have used Aqua data, and the data have also provided wide-ranging practical benefits.
- The mission likely can continue into 2021 and perhaps beyond.

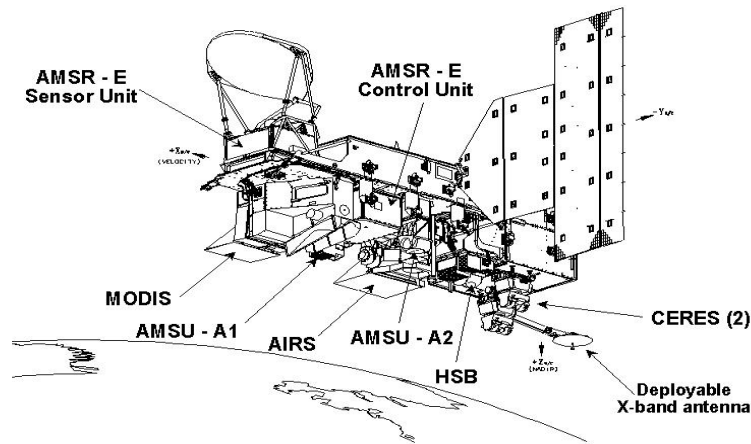
(photo by Bill Ingalls)



Aqua launch May 4, 2002



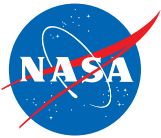
Aqua's Instrument Suite



- **Operating Instruments**
 - AIRS: Atmospheric Infrared Sounder
 - AMSU: Advanced Microwave Sounding Unit
 - CERES: Clouds and the Earth's Radiant Energy System (2 copies)
 - MODIS: Moderate Resolution Imaging Spectroradiometer
- **Non-Operating Instruments**
 - HSB: Humidity Sounder for Brazil (provided by Brazil; non-operational since February 2003)
 - AMSR-E: Advanced Microwave Scanning Radiometer for the Earth Observing System (provided by Japan; worked well until October 2011; some operations since then; turned off on March 2, 2016)



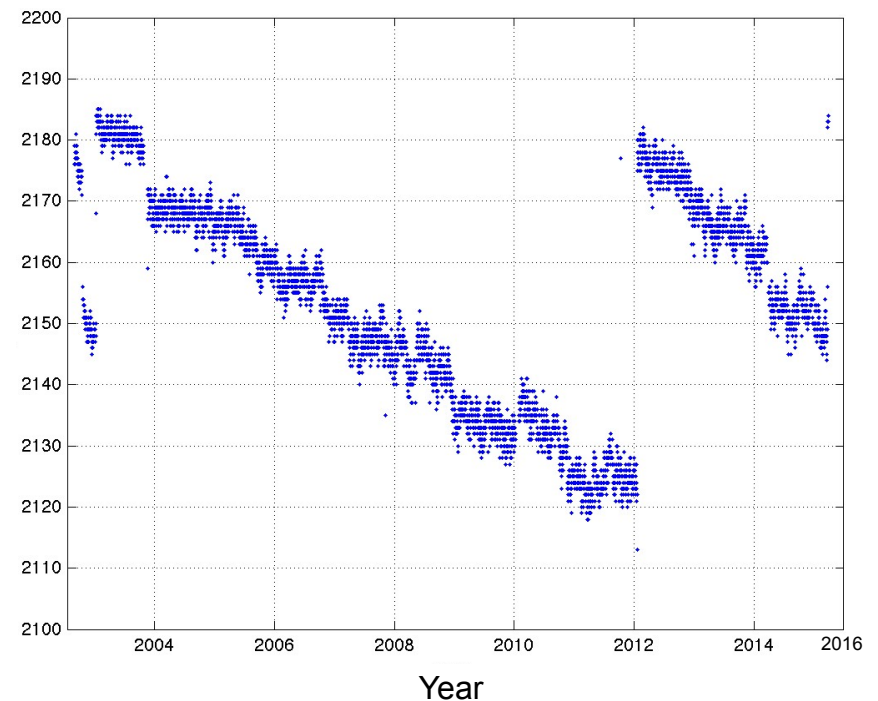
Aqua pre-launch (courtesy of Northrop Grumman)



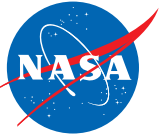
Status of Aqua's Operating Earth-Observing Instruments

- **AIRS – Excellent health**
 - Only ~ 200 of 2378 infrared channels are degraded (due to radiation).
 - Cooler A telemetry has been frozen since 3/28/2014 but with no impact on science.
- **AMSU – Good health**
 - 12 of 15 channels continue to perform well (Channels 4, 5, and 7 are degraded and have been removed from Level 2 processing; Channel 6 is degrading but at a slow enough rate to expect many additional years of useful performance).
- **CERES FM-3 – Excellent health**
 - All channels are fully operational, and the instrument continues to be capable of operating in either cross-track or rotating-azimuth-plane mode.
- **CERES FM-4 – Good health**
 - The shortwave channel failed on 3/30/2005, but the two other channels remain operational.
- **MODIS – Excellent health**
 - All components remain on primary hardware.
 - Three of four 10 W lamps used for calibration have failed.

Time Series of the Number of Properly Working AIRS Infrared Channels (out of 2378)



(plot from the AIRS Science Team)

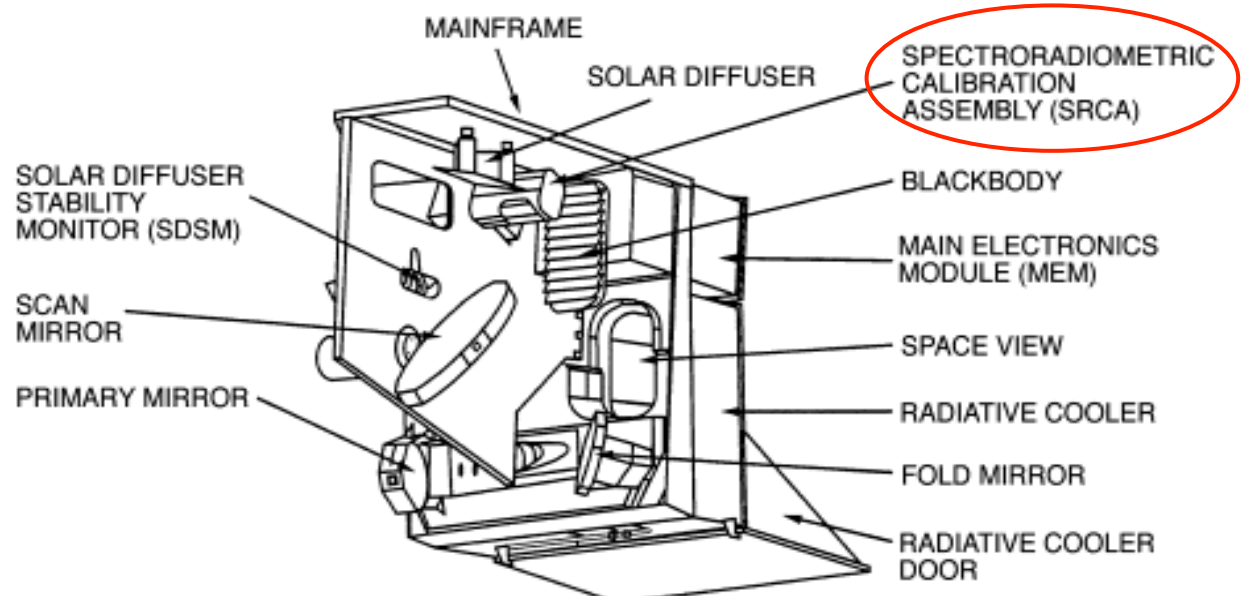


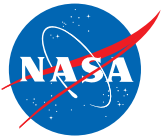
Recent MODIS Lamp Failure

- Background
 - MODIS has four 10-Watt and two 1-Watt lamps used in calibration.
 - Two (Lamp #2 and Lamp #3) of the four 10-Watt lamps failed years ago.
- MODIS calibration activities on June 30 and July 11, 2016 ended prematurely. Analysis determined the cause to be a failure of Lamp #4, leaving only Lamp #1.
- The MODIS calibration activities have consequently been revised.
 - Use only Lamp #1.
 - Reduce the frequency of the calibrations (from once a month to every 3 months for radiometric calibration and from every 4 months to every 6 months for spectral calibration).
- Fortunately, the science impact is minor, and this would remain the case even if Lamp #1 were to fail as well.

Cross-section of MODIS highlighting the calibration and characterization instrumentation

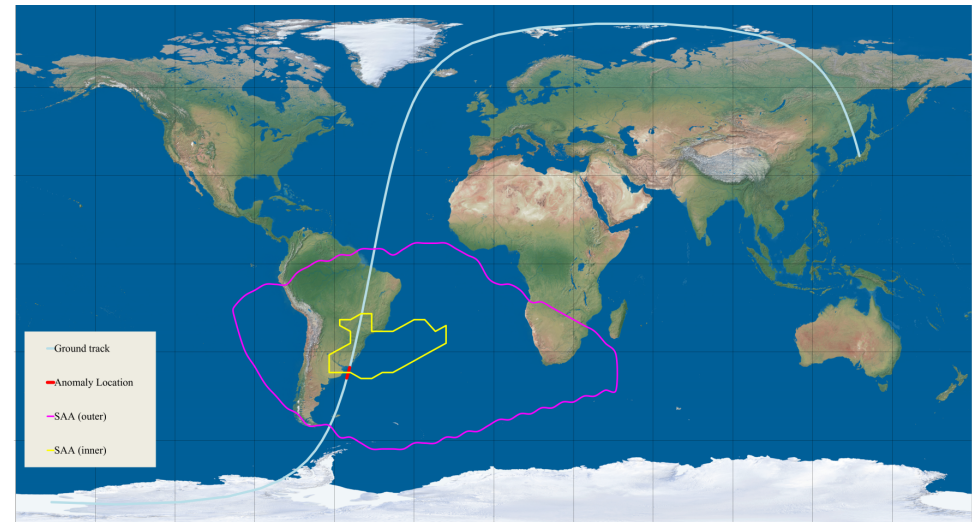
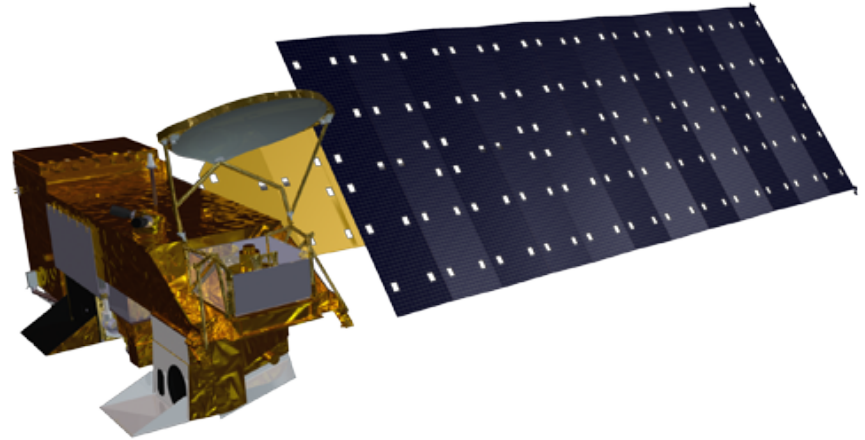
(from Jack Xiong/MODIS Team)



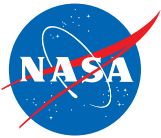


Status of the Aqua Spacecraft Bus and Solar Array

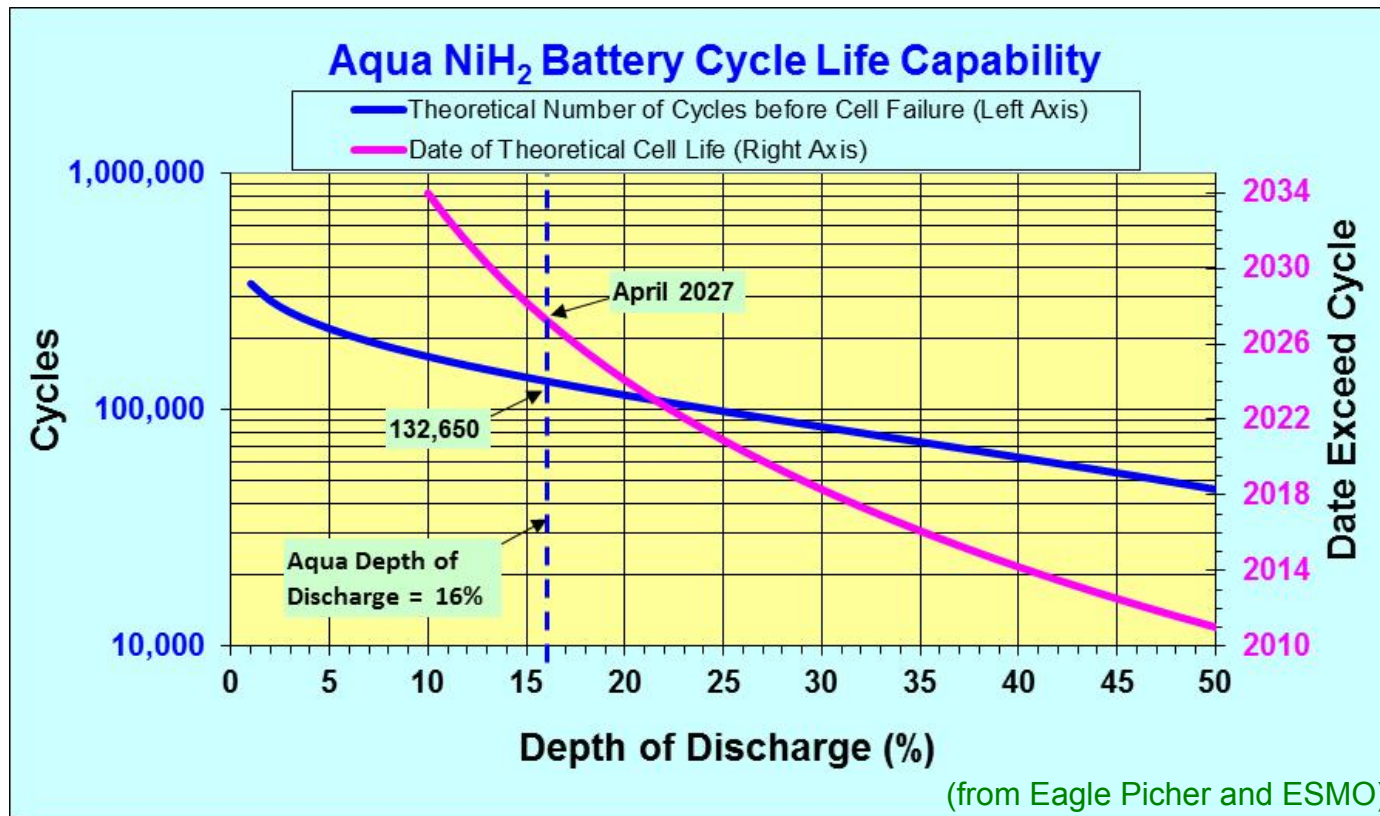
- Overall status – Excellent
 - All components remain on primary hardware.
 - 118 of the 132 strings of solar cells continue to operate (14 have failed).
 - All 24 cells in the main Aqua battery continue to operate nominally.
- August 8, 2016 Anomaly: Reboot of the Transponder Interface Electronics (TIE)
 - Location: Within the South Atlantic Anomaly.
 - Impact: The MODIS and CERES science data were incorrectly time tagged.
 - Actions taken:
 - The clock used by MODIS and CERES was reset on 8/9/16.
 - The incorrectly tagged CERES data were corrected by 8/12/16.
 - The incorrectly tagged MODIS data were corrected by 8/23/16.



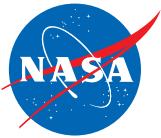
(from Earth Science Mission Operations [ESMO])



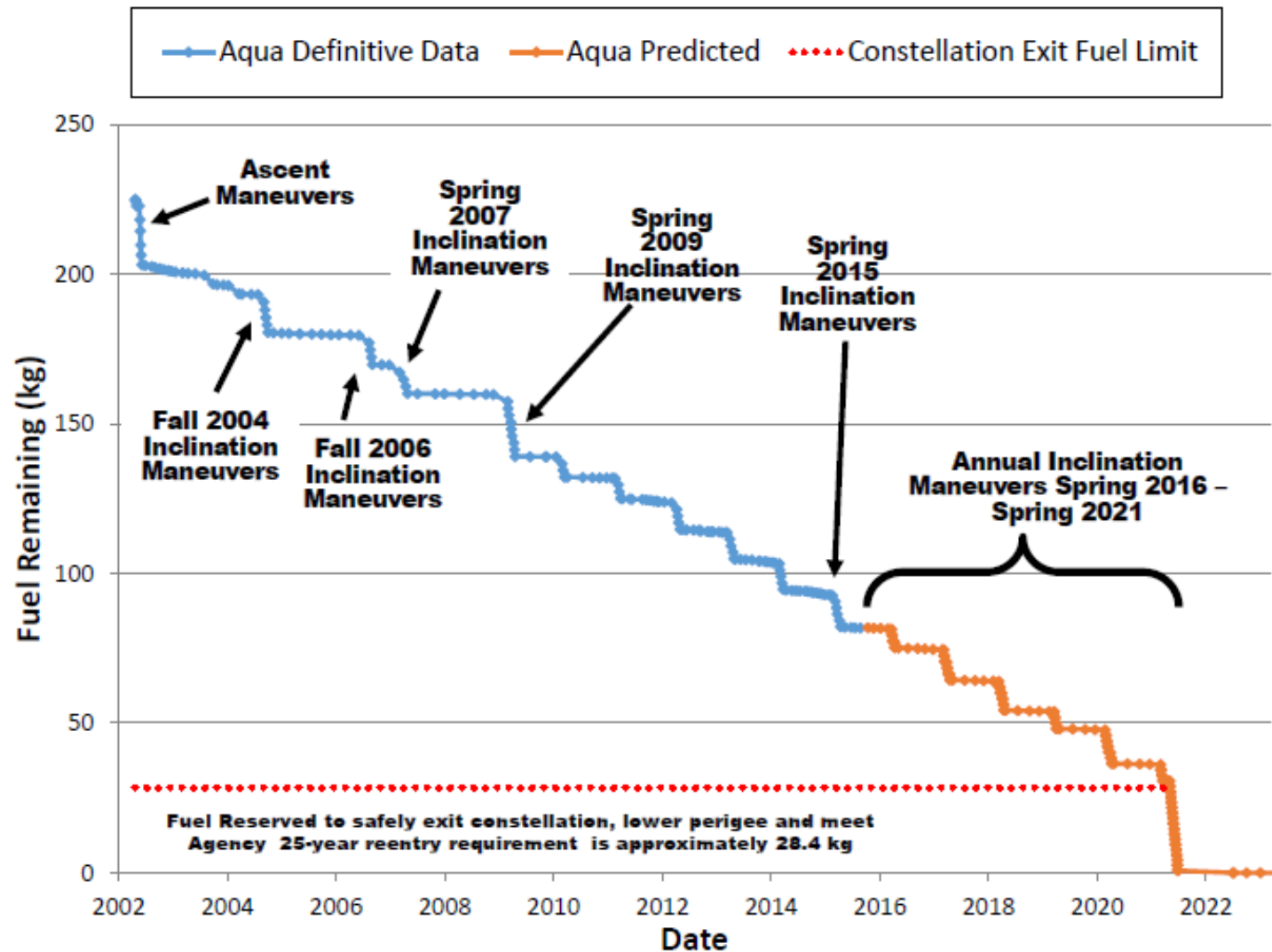
Aqua Battery Status



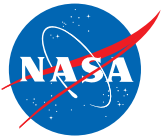
- Aqua has a 24-cell, nickel-hydrogen (NiH₂) battery manufactured by Eagle Picher.
- All 24 cells remain fully operational, with the only anomaly having occurred back on September 2, 2005.
- Aqua has a 16% depth of discharge, at which level Eagle Picher's analyses with similar battery cells suggest that the Aqua battery could last until April 2027, at which point it will have completed 132,650 orbits.



Aqua Spacecraft Fuel Levels Over Time



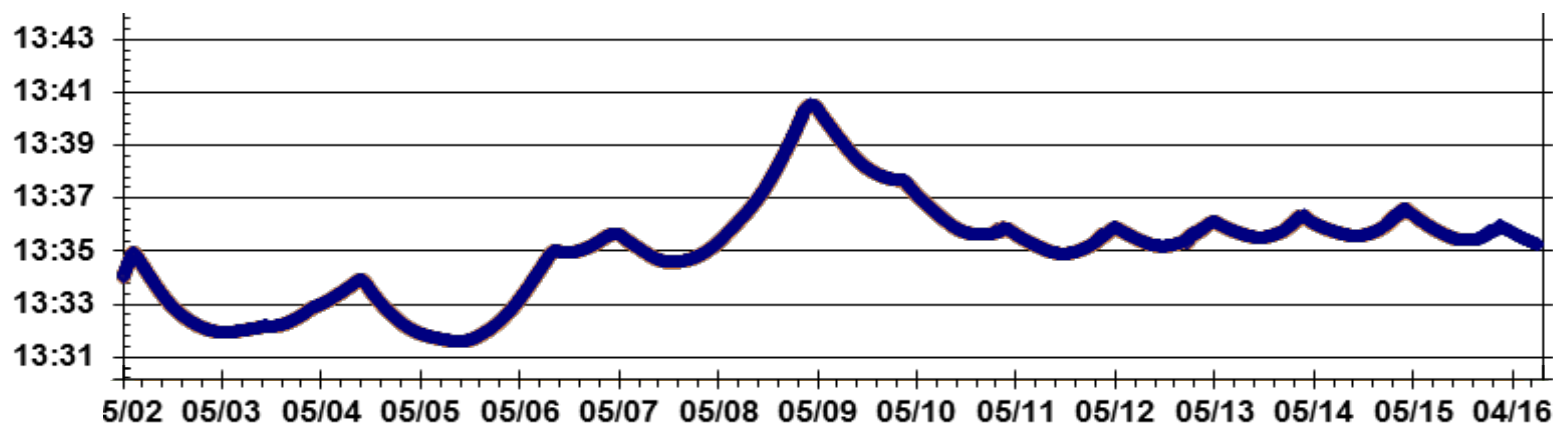
(from ESMO)



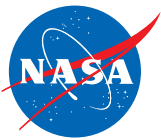
Possible Means of Extending the Aqua Mission

- Reduce the frequency of the maneuvers
- Do the maneuvers more efficiently
- Exit the A-Train constellation by lowering 4 km rather than the originally planned 19 km
- Robotically refuel the fuel tank

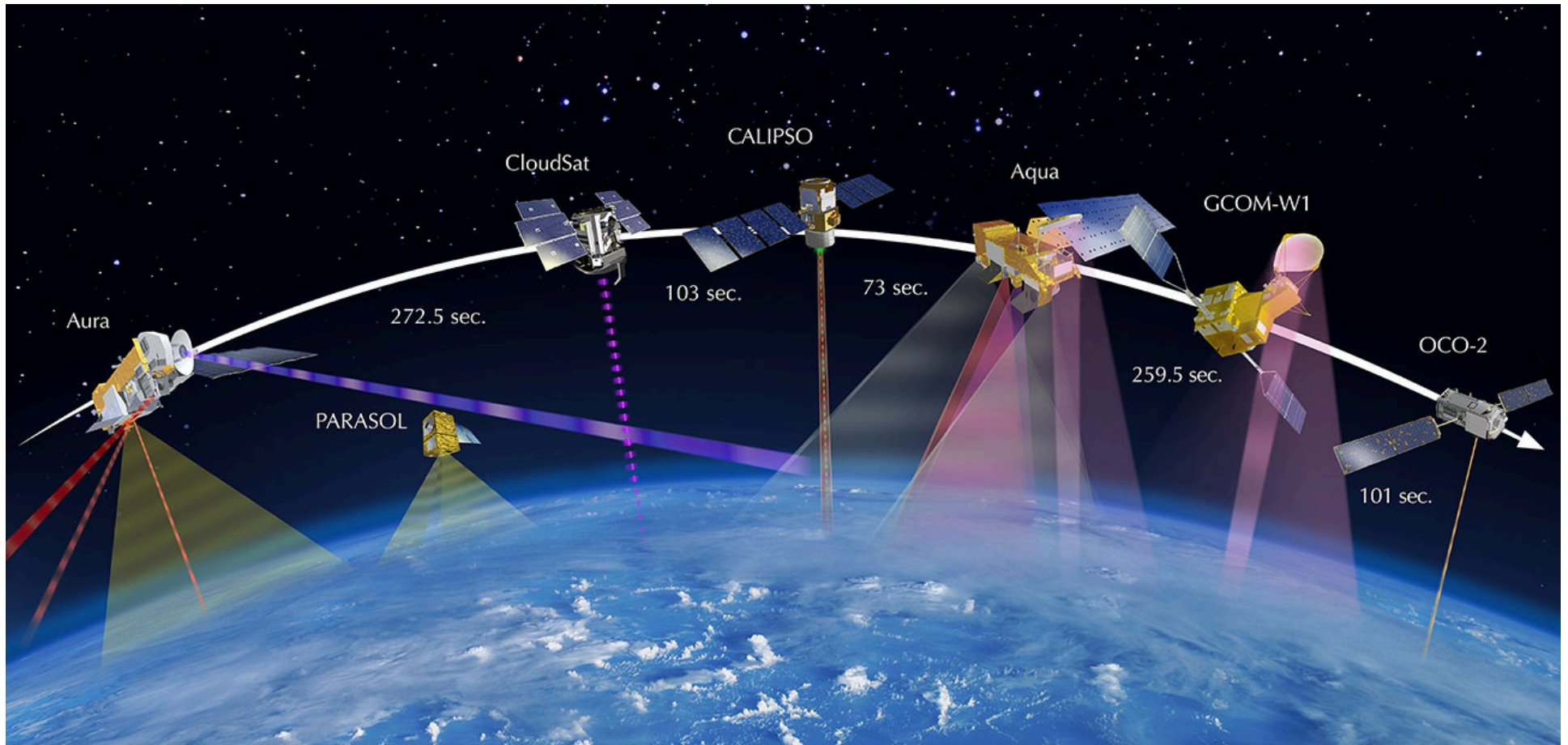
Time series of Aqua Mean Local Time (hour:minute) at the northward equatorial crossing



(modified from an ESMO plot)



A-Train



(from 2017 A-Train Symposium first circular)

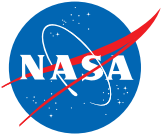
Acronyms

CALIPSO = Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations

GCOM-W1 = Global Change Observation Mission – Water 1 (JAXA mission)

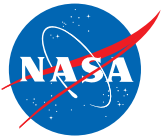
OCO-2 = Orbiting Carbon Observatory 2

PARASOL = Polarization and Anisotropy of Reflectances for Atmospheric Sciences coupled with Observations from a Lidar

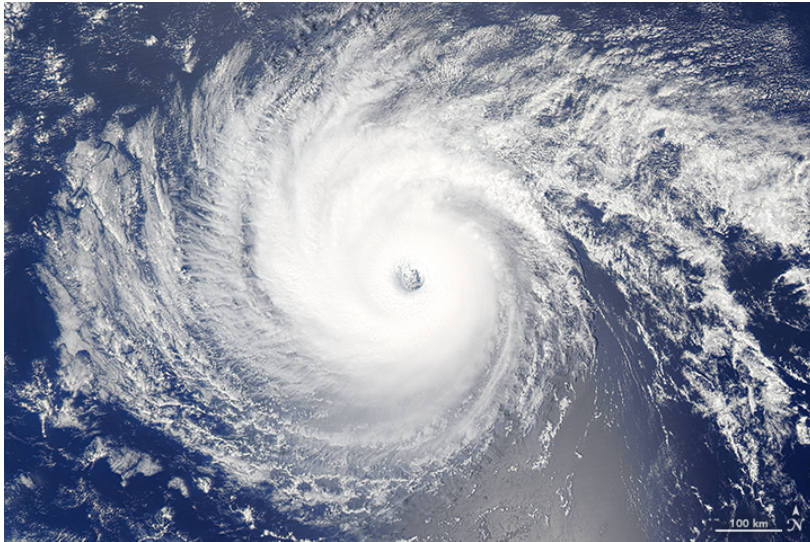


2017 Senior Review Schedule

- **Sunday 12/11/2016:** Kickoff meeting at AGU, 4:00 p.m., at the Marriott Union Square Hotel.
- **Tuesday 12/20/2016:** Call letter from NASA HQ.
- **Friday 3/3/2017:** Proposals due to NASA HQ.
- **Friday 4/21/2017:** Questions from Science Panel due to Missions.
- **Tuesday – Thursday 5/9-11/2017:** Mission presentations to the Science Review Panel.



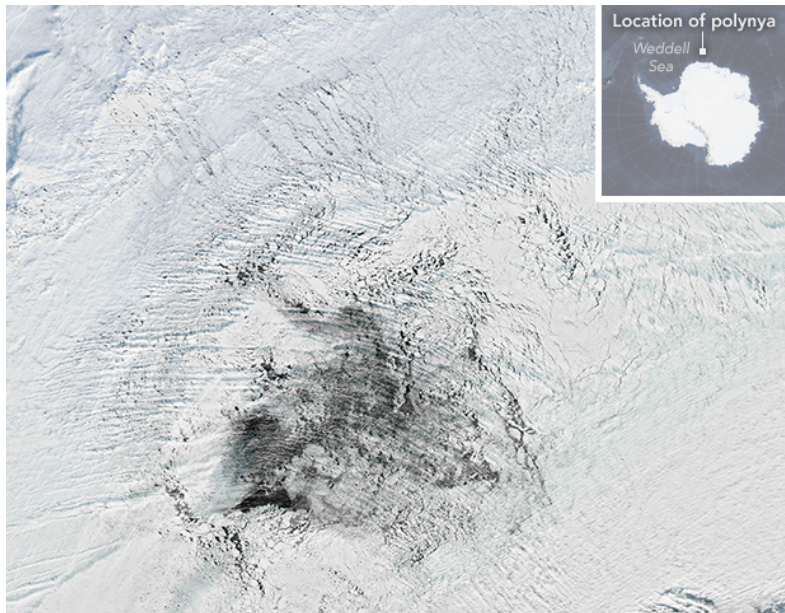
Aqua MODIS Imagery of Recent Events in the News



Hurricane Lester approaching Hawaii, 9/1/16



Blue Cut fire threatening San Bernardino, 8/16/16



Weddell Polynya, 8/14/16



Flooding of the Ganges River, 9/1/16, as mapped by the Dartmouth Flood Observatory, based on MODIS data.

(imagery from the Earth Observatory)